

# **Appendix A**

## **Literature Search Regarding Detection and Quantitation Limit Approaches**

---

### **Introduction**

Beginning in 2001, DynCorp staff conducted a search of published literature to identify articles that discuss detection and quantitation limit approaches. This literature search effort was conducted under EPA Contract No. 68-C-01-091 to support an evaluation of detection and quantitation limit approaches by the EPA Office of Water.

The principal goal of this literature search effort was to determine if any new detection or quantitation limit approaches had been published in the literature since an earlier search conducted for EPA by Science Applications International Corporation (SAIC) in 1997 and 1998. That search resulted in an annotated bibliography developed by SAIC and delivered to EPA in 1998.

In August 2002, EPA included the literature search results in a draft Technical Support Document (TSD) that was submitted for formal peer review. As part of the charge to the peer reviewers, EPA asked them to identify any additional references. Following EPA's review of the suggested additional references, DynCorp included those relevant to the TSD in the literature search results summarized in Attachment 1.

### **How the search was conducted**

This search was conducted using two major techniques:

- a search of an on-line citation index (an index of articles cited by other authors), and
- a general on-line search of literature.

### **On-line citation index search**

Because the search was intended to identify detection and quantitation limit approaches and not specific numeric limits associated with a particular analytical method, DynCorp began by searching for references to the major approaches known to EPA. These included the Agency's method detection limit (MDL) and any other terms that have been suggested to the Agency as alternative detection or quantitation limit approaches. In addition to searching for these approaches, DynCorp also searched the citation index to identify references to the original authors of these approaches and for any other authors who either cited the original approaches, the original papers underlying those approaches, or the authors of those approaches. DynCorp used a similar approach to find any papers that cited the references identified in the earlier literature search by SAIC.

DynCorp staff evaluated the full title of each identified citation to determine its relevance to EPA's objective. Where available electronically and at no additional cost, DynCorp staff also reviewed the abstract and/or full paper to further characterize relevance. All papers that were determined to be relevant, or even possibly relevant, were obtained in hardcopy or electronic format for evaluation by EPA.

After reviewing all papers determined to be relevant to EPA's objective, DynCorp examined all of the references cited in those papers to identify additional papers of interest. These, too, were obtained in hardcopy or electronic format for evaluation by EPA, except where noted below.

## **General on-line literature search**

DynCorp performed an on-line direct search of published literature (e.g., a literature database of published articles, not a citation index) using general terms such as "detection limit," "quantitation limit," or "calibration." As expected, this approach returned a very large numbers of papers that mention these terms, even if the focus of the paper was on something far removed from the development or assessment of approaches about detection and quantitation, and proved to be of limited value in serving EPA's objectives for the search. Therefore, DynCorp discontinued this effort and narrowed our on-line literature search to a search for additional, uncited works by authors of the approaches known to EPA or identified through the citation index approach.

Papers determined to be relevant to EPA's objective were obtained in electronic or hardcopy format for evaluation by EPA, except where noted below.

## **How the results are presented**

DynCorp identified a total of 161 relevant publications using the approach described above. Thirty-three (33) of these publications were also identified in the earlier search by SAIC. Of the 128 remaining publications, 35 were published since the SAIC search was completed.

The peer reviewers suggested additional publications covering a variety of topics, including: quality control, analysis of mercury, and approaches to dealing with censored data. EPA reviewed the citations from the peer reviewers and determined that 20 directly addressed detection or quantitation approaches. In particular, EPA noted that the issue of censored data applies regardless of the specific detection or quantitation limit associated with the data, so those citations dealing with censored data were not included.

Each of the 181 publications identified in the search is listed in Attachment 1, which provides the title, year of publication, authors, and source citation. The citations for the 33 papers identified in the earlier search by SAIC are included in the attachment, and can be identified by the phrase "annotated only" in parentheses after the title of the paper.

The final column of the attached spreadsheet is labeled "Category." All of the citations identified in the SAIC literature search and the current search conducted by DynCorp were placed in one of the six following categories, based on the principal characteristic of the article:

- Background - The citation discusses background information (including early works by Currie, Kaiser, and others).
- Calibration concept - The citation primarily deals with calibration of analytical instrumentation
- Critique - The major thrust of the citation is to critique one or more approaches, as opposed to introducing a new approach
- Multi-laboratory approach - The citation describes an approach to developing detection and/or quantitation limits that relies on multi-laboratory measurements
- Single-laboratory approach - The citation describes an approach to developing detection and/or quantitation limits that relies on single-laboratory measurements
- Single-laboratory, multi-level approach - The citation describes an approach to developing detection and/or quantitation limits that relies on single-laboratory measurements but explicitly includes multiple concentrations.

Although there is some degree of overlap between categories, and some papers could probably be classified in more than one category, each citation was classified into only one category for the purposes of this search.

A seventh category called "Not found" was used for three papers that were identified in the literature search, but copies of which could not readily be obtained. One paper is from a German journal that was not available via interlibrary loan. A second article was also not available via interlibrary loan. The third citation is an abstract by Currie, from 1983. Given that the work of Currie is well-represented in the other citations and the fact that this citation appears to be only an abstract, additional efforts were not expended to obtain a copy.

The 20 publications suggested by the peer reviewers were all included at the end of the list, under an eighth category called "Suggested by a peer reviewer."

The references presented in the table were sorted by category and year of publication and are displayed with the most recent citations in each category first.

## **Summary**

The principal goal of this literature search effort was to determine if any new detection or quantitation limit approaches had been published in the literature since the search by SAIC in 1997 - 1998. As anticipated, citations were identified that relate to the recent efforts of the International Organization for Standardization (ISO), the International Union of Pure and Applied Chemists (IUPAC), and the ASTM International. Additional articles critiquing various approaches were identified as well.

However, no previously unknown detection or quantitation limit approaches were uncovered as a result of this effort.

Likewise, the references suggested by the peer reviewers provided additional details and applications of existing detection and quantitation approaches, but did not suggest any approaches that had not already been identified.

## Results of the 2001 Literature Search

Title	Year	Author	Source	Category
Some Case Studies of Skewed (and other ab-normal) Data Distributions Arising in Low-Level Environmental Research	2001	L.A. Currie	Fresenius Journal of Analytical Chemistry 370: 705-718	Background
Legislative Limits Below Detection Capability	2000	S.L.R. Ellison, V.J. Barwick, A. Williams	Accreditation Quality Assurance 5: 308-313	Background
International Recommendations Offered on Analytical Detection and Quantification Concepts and Nomenclature	1999	L.A. Currie	Analytica Chimica Acta 391: 103	Background
Detection and Quantitation Limits: Origins and Historical Overview	1999	L.A. Currie	Analytica Chimica Acta 391: 127-134	Background
1996 ASMS Fall Workshop: Limits to Confirmation, Quantitation, and Detection	1997	R. Baldwin, R.A. Bethem, R.K. Boyd, W.L. Budde, T. Cairns, R.D. Gibbons, J.D. Henion, M.A. Kaiser,	Journal of the American Society for Mass Spectrometry 8: 1180-1190	Background
Measurement precision and 1/f Noise in Analytical Instruments	1996	Y. Hayashi, R. Matsuda, R.B. Poe	Journal of Chromatography A 722: 157-167	Background
Fossil- and Bio-mass Combustion: C-14 for Source Identification, Chemical Tracer Development, and Model Validation	1994	L.A. Currie, G.A. Klouda, D.B. Klinedinst, A.E. Sheffield, A.J.T. Jull, D.J. Donahue, M.V. Connolly	Nuclear Instr. And Methods in Physics Res. B 92: 404-409	Background
Interlaboratory Comparison of Instruments Used for the Determination of Elements in Acid Digestates of Solids	1994	D.E. Kimbrough, J. Wakakuwa	Analyst 119: 383-388	Background
Throwaway Data	1994	L.H. Keith	Environmental Science & Technology 28: 389A-390A	Background
EPA's Office of Water Surges Toward MDL Solution	1994	Larry Keith	Radian	Background
In Pursuit of Accuracy: Nomenclature, Assumptions, and Standards	1992	L.A. Currie	Pure & Applied Chemistry 64:455-472	Background
Interlaboratory Aspects of Detection Limits Used for Regulatory and Control Purposes	1988	L.B. Rogers	ACS Symposium Series 361:94-108	Background
Noise and Detection Limits in Signal-Integrating Analytical Methods	1988	H.C. Smit, H. Steigstra	ACS Symposium Series 361:126-148	Background
Effects of Analytical Calibration Models on Detection Limit Estimates	1988	K.G. Owens, C.F. Bauer, C.L. Grantr	ACS Symposium Series 361:194-207	Background
Real-World Limitations to Detection	1988	D. Kurtz, J. Taylor, L. Sturdivan, W. Crummett, C. Midkiff, R. Watters Jr, L. Wood, W. Hanneman, W. Horwitz	ACS Symposium Series 361:288-316	Background
Detection Limits - A Systematic Approach to Detection Limits is Needed When Trace Determinations are to be Performed	1986	S.A. Borman	Analytical Chemistry 58: A986	Background
Chemometrics and Analytical Chemistry	1984	L.A. Currie	Chemometrics 56: 115-146	Background
Quality Control in Water Analyses	1983	C. Kirchmer	ES&T 17: 174A-181A	Background
Validation of Analytical Methods	1983	J.K. Taylor	Analytical Chemistry 55: 600A-602A, 608A	Background
Trace Analyses for Wastewaters - Author's response	1982	D. Foerst	Envir. Sci. & Tech. 16: 430A - 431A	Background

Title	Year	Author	Source	Category
Zur Theorie der Eichfunktion bei der spektrochemischen Analyse	1982	V.H. Kaiser	DK 535: 309-319	Background
The Reliability of Detection Limits in Analytical Chemistry	1980	J.D. Winefordner, J.L. Ward	Analytical Letters 13: 1293-1297	Background
A Review and Tutorial Discussion of Noise and Signal-to-Noise Ratios in Analytical Spectrometry - I. Fundamental Principles of Signal-to-Noise Ratios	1978	C.T.J. Alkemade, W. Snelleman, G.D. Boutilier, B.D. Pollard, J.D. Winefordner, T.L. Chester, N. Omenetto	Spectrochimica Acta 33B: 383-399	Background
A Review and Tutorial Discussion of Noise and Sign-to-Noise Ratios in Analytical Spectrometry - II. Fundamental Principles of Signal-to-Noise Ratios	1978	G.D. Boutilier, B.D. Pollard, J.D. Winefordner, T.L. Chester, N. Omenetto	Spectrochimica Acta 33B: 401-415	Background
A Tutorial Review of Some Elementary Concepts in the Statistical Evaluation of Trace Element Measurements	1978	P.W.J.M. Boumans	Spectrochimica Acta 33B: 625-634	Background
Analysis of Lead in Polluted Coastal Seawater	1976	C. Patterson, D. Settle, B. Glover	Marine Chemistry 4: 305-319	Background
Multielement Analysis with an Inductively Coupled Plasma/Optical Emission System	1976	R.M. Ajhar, P.D. Dalager, A.L. Davison	American Laboratory 72-78	Background
Interlaboratory Lead Analyses of Standardized Samples of Seawater	1974	P. Brewer, N. Frew, N. Cutshall, J.J. Wagner, R.A. Duce, P.R. Walsh, G.L. Hoffman, J.W.R. Dutton, W.F. Fitzgerald	Marine Chemistry 2: 69-84	Background
Statistical and Mathematical Methods in Analytical Chemistry	1972	L.A. Currie, J.J. Filliben, J.R. DeVoe	Anal. Chem. 44: 497R-512R	Background
Studies of Flame and Plasma Torch Emission for Simultaneous Multi-Element Analysis- I. Preliminary Investigations	1972	P.W.J.M. Boumans, F.J. De Boer	Spectrochimica Acta 27B: 391-414	Background
Quantitative Determination: Application to Radiochemistry	1968	Lloyd Currie	Anal. Chem. 40: 586-593	Background
Qualitative and Quantitative Sensitivity in Flame Photometry	1966	J. Ramirez-Munoz	Talanta 13: 87-101	Background
The Limit of Detection of Analytical Methods	1962	J.B. Roos	Analyst 87: 832-833	Background
A Careful Consideration of the Calibration Concept	2001	S.D. Phillips, W.T. Estler, T. Doiron, K.R. Eberhardt, M.S. Levenson	Journal of Research of the National Institute of Standards and Technology 106: 371-379	Calibration
Weighted Random-Effects Regression Models with Application to Interlaboratory Calibration	2001	R.D. Gibbons, D.K. Bhaumik	Technometrics 43: 192-198	Calibration
Guidelines for Calibration in Analytical Chemistry-Part I. Fundamentals and Single Component Calibration (IUPAC recommendations 1998)	1998	K. Danzer, L.A. Currie	Pure and Applied Chemistry 70: 993-1014	Calibration
A Comparison of Uncertainty Criteria for Calibration	1996	R.W. Mee, K.R. Eberhardt	Technometrics 38: 221-229	Calibration
Constant-Width Calibration Intervals for Linear Regression	1994	K.R. Eberhardt, R.W. Mee	Journal of Quality Technology 26: 21-29	Calibration
Regression and Calibration with Nonconstant Error Variance	1990	M. Davidian, P.D. Haaland	Chemometrics and Intelligent Laboratory Systems 9: 231-248	Calibration
Calibration with Randomly Changing Standard Curves	1989	D.F. Vecchia, H.K. Iyer, P.L. Chapman	Technometrics 31: 83-90	Calibration

Title	Year	Author	Source	Category
Linear Calibration When the Coefficient of Variation is Constant	1988	Y.C. Yao, D.F. Vecchia, H.K. Iyer	Probability and Statistics: Essays in Honor of Franklin A. Graybill, 297-309	Calibration
Analytical Method Comparisons by Estimates of Precision and Lower Detection Limit	1986	D.M. Holland, F.F. McElroy	Environmental Science & Technology 20: 1157-1161	Calibration
Design Considerations for Calibration	1986	J.P. Buonaccorsi	Technometrics 28: 149-155	Calibration
Multivariate Calibration when the Error Covariance Matrix is Structured	1985	T. Naes	Technometrics 27: 301-311	Calibration
An Implementation of the Scheffé Approach to Calibration Using Spline Functions, Illustrated by a Pressure-Volume Calibration	1982	J.A. Lechner, C.P. Reeve, C.H. Spiegelman	Technometrics 24: 229-234	Calibration
Measuring and Maximizing Precision in Analyses Based on Use of Calibration Graphs	1982	D.G. Mitchell, J.S. Garden	Talanta 29: 921-929	Calibration
Calibration in Quantitative Analysis: Part2. Confidence Regions for the Sample Content in the Case of Linear Calibration Relations	1981	J. Agterdenbos, F.J.M.J. Maessen, J. Balke	Analytica Chimica Acta 132: 127-137	Calibration
Design Aspects of Scheffe's Calibration Theory using Linear Splines	1980	C.H. Spiegelman, W.J. Studden	Journal of Research of the National Bureau of Standards 85: 295-304	Calibration
Nonconstant Variance Regression Techniques for Calibration-Curve-Based Analysis	1980	J.S. Garden, D.G. Mitchell, W.N. Mills	Anal. Chem. 52: 2310-2315	Calibration
Calibration in Quantitative Analysis	1979	J. Agterdenbos	Analytica Chimica Acta 108: 315-323	Calibration
Calibration Curves with Nonuniform Variance	1979	L. Schwartz	Analytical Chem. 51: 723-727	Calibration
Elimination of the Bias in the Course of Calibration	1978	L.J. Naszódi	Technometrics 20: 201-205	Calibration
Optimal Designs for the Inverse Regression Method of Calibration	1973	M.A. Thomas, R.H. Myers	Communications in Statistics 2: 419-433	Calibration
A Statistical Theory of Calibration	1973	H. Scheffé	The Annals of Statistics 1: 1-37	Calibration
On the Problem of Calibration	1972	G.K. Shukla	Technometrics 14: 547-553	Calibration
Statistical Processing of Calibration Data in Quantitative Analysis by Gas Chromatography	1970	P. Bocek, J. Novak	J. Chromatog. 51: 375-383	Calibration
Estimation of a Linear Function for a Calibration Line: Consideration of a Recent Proposal	1969	J. Berkson	Technometrics 11: 649-660	Calibration
A Note on Regression Methods in Calibration	1969	E.J. Williams	Technometrics 11: 189-192	Calibration
Classical and Inverse Regression Methods of Calibration in Extrapolation	1969	R.G. Krutchkoff	Technometrics 11: 605-608	Calibration
Optimal Experimental Designs for Estimating the Independent Variable in Regression	1968	R.L. Ott, R.H. Myers	Technometrics 10: 811-823	Calibration
Classical and Inverse Regression Methods of Calibration	1967	R.G. Krutchkoff	Technometrics 9: 425-439	Calibration
The Interpretation of Certain Regression Methods and their Use in Biological and Industrial Research	1939	C. Eisenhart	The Annals of Mathematical Statistics 10: 162-186	Calibration

Title	Year	Author	Source	Category
The Three "Rs" for Relevant Detection, Reliable Quantitation and Respectable Reporting Limits	2000	Ann Rosecrance	Env. Testing & Anal. 9: 13,50	Critique
Detection and Quantification Capabilities and the Evaluation of Low-Level Data: Some International Perspectives and Continuing Challenges	2000	L.A. Currie	Journal of Radioanalytical and Nuclear Chemistry 245: 145-156	Critique
Realistic Detection Limits from Confidence Bands	1999	J.R. Burdge, D.L. McTaggart, S.O. Farwell	Journal of Chemical Education 76: 434-439	Critique
Response to Comment of "An Alternative Minimum Level Definition for Analytical Quantification"	1999	Henry Kahn, William Telliard, Chuck White	Env. Sci. & Tech. 33: 1315	Critique
Comment on "An Alternative Minimum Level Definition for Analytical Quantification"	1999	H.G. Rigo	Env. Sci & Tech. 33: 1311-1312	Critique
Response to Comment on "An Alternative Minimum Level Definition for Analytical Quantification"	1999	Robert Gibbons, David Coleman, Ray Maddalone	Env. Sci. & Tech. 33: 1313-1314	Critique
Comment on "An Alternative Minimum Level Definition for Analytical Quantification"	1998	Henry Kahn, William Telliard, Chuck White	Envir. Sci & Tech 32: 2346-2348	Critique
Response to Comment on "An Alternative Minimum Level Definition for Analytical Quantification"	1998	Robert Gibbons, David Coleman, Ray Maddalone	Envir. Sci & Tech 32: 2349-2353	Critique
A Discussion of Issues Raised by Lloyd Currie and a Cross Disciplinary View of Detection Limits and Estimating Parameters that are Often At or Near Zero	1997	C.H. Spiegelman	Chemometrics and Intelligent Laboratory Systems 37: 183-188	Critique
A Mock Trial for Critical Values (Detection Limits)	1997	C.H. Spiegelman, P. Tarlow	STATS: The Magazine for Students of Statistics 20: 13-16	Critique
Comment on "An Alternative Minimum Level Definition for Analytical Quantification"	1997	David Kimbrough	Envir. Sci. & Tech. 31: 3727-3728	Critique
The Smallest Concentration	1997	R.F. Moran, E.N. Brown	Clinical Chemistry 43: 856-857	Critique
A Statistical Overview of Standard (IUPAC and ACS) and New Procedures for Determining the Limits of Detection and Quantification: Application to Voltammetric and Stripping Techniques (Technical Report)	1997	J. Mocak, A.M. Bond, S. Meitchell, G. Scollary	Pure and Applied Chemistry 69: 297-328	Critique
Response to Comment on "An Alternative Minimum Level Definition for Analytical Quantification"	1997	R.D. Gibbons, D.E. Coleman, R.F. Maddalone	Envir. Sci. & Tech 31: 3729-3731	Critique
Some Conceptual and Statistical Issues in Analysis of Groundwater Monitoring Data	1996	R.D. Gibbons	Environmetrics 7: 185-199	Critique
Some Statistical and Conceptual Issues in the Detection of Low Level Environmental Pollutants	1995	Robert Gibbons	Environ. & Ecol. Statistics 2: 125-167	Critique
Comment on "Method Detection Limits in Solid Waste Analysis"	1995	D.E. Coleman	Environmental Science & Technology 29: 279-280	Critique
Comment on "Method Detection Limits in Solid Waste Analysis"	1995	Janice Wakakuwa, David Kimbrough	Envir. Sci. & Tech. 29: 281-282	Critique
"You Can't Compute With Less-Thans"	1994	Ken Osborn, Ann Rosecrance	East Bay Municipal Utility District, Core Laboratories	Critique
Limits of Detection	1994	N. Cressie	Chemometrics Intelligent Laboratory Systems 22: 161-163	Critique

Title	Year	Author	Source	Category
Conflicting Perspectives About Detection Limits and About the Censoring of Environmental Data	1994	M.J.R. Clark, P.H. Whitfield	Water Resources Bulletin 30: 1063-1079	Critique
Limit of Discrimination, Limit of Detection and Sensitivity in Analytical Systems	1994	R. Ferrus, M.R. Egea	Analytica Chimica Acta 287: 119-145	Critique
Discussion of: A Study of the Precision of Lead Measurements at Concentrations Near the Method Limit of Detection	1994	B.R. Nott, R.R. Maddalone	Water Environment Research 66: 853-854	Critique
Limits of Detection Methodologies	1993	J. Lindstedt	Plating and Surface Finishing 80: 81-86	Critique
Method Detection Limits in Solid Waste Analysis	1993	David Kimbrough, Janice Wakakuwa	Enviro. Sci. & Tech 27: 2692-2699	Critique
Defining the Limits	1993	G. Stanko, W. Krochta, A. Stanley, T. Dawson, K. Hillig, R. Javick, R. Obrycki, B. Hughes, F. Saksa	Environmental Lab 1: 16-20	Critique
A Study of the Precision of Lead Measurements at Concentrations Near the Method Limit of Detection	1993	P.M. Berthouex	Water Environment Research 65: 620-629	Critique
Detection Limit Concepts: Foundations, Myths, and Utilization	1992	D.A. Chambers, S.S. Dubose, E.L. Sensintaffar	Health Phys. 63: 338-340	Critique
Difficulties Related to Using Extreme Percentiles for Water Quality Regulations	1991	P. M. Berthouex, Ian Hau	Research Journal WPCF 63: 873-879	Critique
A Simple Rule for Judging Compliance Using highly Censored Samples	1991	P. M. Berthouex, Ian Hau	Research Journal WPCF 63: 880-886	Critique
Current Method for Setting Dioxin Limits in Water Requires Reexamination	1990	J. LaKind, E. Rifkin	Env. Sci. & Tech 24: 963-965	Critique
Kaiser 3-Sigma Criterion - A Review of the Limit of Detection	1990	L.S. Oresic, V. Grdinic	Acta Pharmaceutica Jugoslavica 40: 21-61	Critique
MCL Noncompliance: Is the Laboratory at Fault?	1990	Steven Koorse	AWWA p53-58	Critique
Qualitative or Quantitative Characterization of Spectrographic Methods? The Detection and Determination Limits	1990	Karol Florian	Chemia Analityczna 35:129-139	Critique
False Positives, Detection Limits, and Other Laboratory Imperfections: The Regulatory Implications	1989	Steven Koorse	Environmental Law Reporter 19: 10211-10222	Critique
Evaluation of Detection Limit Estimators	1988	F.C. Garner, G.L. Robertson	Chemometrics and Intelligent Laboratory Systems 3: 53-59	Critique
Chemometrics - Measurement Reliability	1988	K. Castaneda-Mendez	Clinical Chemistry 34: 2494-2498	Critique
The Detection Limit	1988	P.S. Porter, R.C. Ward, H.F. Bell	Environmental Science & Technology 22: 856-861	Critique
Estimation of Detection Limits for Environmental Analytical Procedures - A Tutorial	1988	Cliff Kirchmer	ACS Symposium Series 361: 78-93	Critique
Limits of Detection	1984	J.K. Taylor	Analytical Chemistry 56: 130A	Critique
Clarification of the Limit of Detection in Chromatography	1984	J.P. Foley, J.G. Dorsey	Chromatographia 18: 503-511	Critique
Limit of Detection: A Closer Look at the IUPAC Definition	1983	Gary Long, J.D. Winefordner	Analytical Chem. 55: 712-724	Critique
Trace Analyses for Wastewaters	1982	C.J. Kirchmer	Envir. Sci. & Tech. 16: 430A	Critique



Title	Year	Author	Source	Category
A comparison of statistical and empirical detection limits	1998	G.C.C. Su	Journal of AOAC International 81: 105-110	Multilab
Challenges in Regulatory Environmetrics	1997	C.B. Davis	Chemometrics Intelligent Laboratory Systems 37: 43-53	Multilab
Determining Quantitation Levels for Regulatory Purposes	1996	P.F. Sanders, R.L. Lippincott, A. Eaton	Journal American Water Works Association 88: 104-114	Multilab
Defining Detection and Quantitation Levels	1993	Raymond Maddalone, James Rice, Ben Edmondson, Babu Nott, Judith Scott	Water Envir. & Tech. Jan.93: 41-44	Multilab
Concept 2000-A Statistical Approach for Analytical Practice - Part I: Limits of Detection, Identification, and Determination	1999	Hadrich J et al.	Deutsche Lebensmittel-Rundschau 1999, 95(10), 428-436	not found
Statistics and Environmental Policy: Case Studies from Long-Term Environmental Monitoring Data	1999	Goudey R et al.	Novart FDN Sym 220; 144-157	not found
The Many Dimensions of Detection in Chemical Analysis	1983	Currie LA	Abstracts of Papers of the American Chemical Society, 185 (Mar), 63-PEST	not found
A Practical Strategy for Determining and Verifying Detection Limits	2001	T. Georgian, K.E. Osborn	Env. Testing & Analysis 10: 13-14	Single lab
Review of the Methods of the US Environmental Protection Agency for Bromate Determination and Validation of Method 317.0 for Disinfection By-Product Anions and Low -Level Bromate	2001	D.P. Hautman, D.J. Munch, C. Frebis, H.P. Wagner, B.V. Pepich	Journal of Chromatography A 920: 221-229	Single lab
Comparison of Detection Limits in Environmental Analysis - Is it Possible? An Approach on Quality Assurance in the Lower Working Range by Verification	2001	S. Geib, J.W. Einax	Fresenius Journal of Analytical Chemistry 370: 673-678	Single lab
On the Assessment of Compliance with Legal Limits, Part I: Signal and Concentration Domains	2001	E. Desimoni, S. Mannino, B. Brunetti	Accreditation Quality Assurance 6: 452-458	Single lab
Capability of Detection - Part 2	2000	ISO	ISO 11843-2	Single lab
Nomenclature in Evaluation of Analytical Methods Including Detection and Quantitation Capabilities (IUPAC Recommendations 1995)	1999	L.A. Currie	Analytica Chimica Acta 391: 105-126	Single lab
New Reporting Procedures Based on Long-Term Method Detection Limits and Some Considerations for Interpretations of Water-Quality Data Provided by the U.S. Geological Survey National Water Quality Laboratory	1999	C. J. Obinger Childress, W. T. Foreman, B. F. Connor, and T. J. Maloney	USGS Open-File Report 99-193, 19 pages.	Single lab
Analyses of Polychlorinated Biphenyls and Chlorinated Pesticides in Biota: Method and Quality Assurance	1999	P. Cleemann, G.B. Paulsen	Journal of AOAC International 82: 1175-1184	Single lab
Detection Limits of Organic Contaminants in Drinking Water	1998	W.M. Draper, J.S. Dhoot, J.S. Dhaliwal, J.W. Remoy, S.K. Perera, F.J. Baumann	Journal of the American Water Works Association 90: 82-90	Single lab
Detection: International Update, and Some Emerging Di-lemmas Involving Calibration, the Blank, and Multiple Detection Decisions	1997	L.A. Currie	Chemometrics and Intelligent Laboratory Systems 37: 151-181	Single lab
Regulations - From an Industry Perspective or Relationships Between Detection Limits, Quantitation Limits, and Significant Digits	1997	D. Coleman, J. Auses, N. Grams	Chemometrics and Intelligent Laboratory Systems 37: 71-80	Single lab
Capability of Detection - Part 1	1997	ISO	ISO 11843-1	Single lab

Title	Year	Author	Source	Category
Determination of Site-Specific Effluent Detection Limits	1996	George Neserke, Harold Taylor	Water Env. Res. 66: 115-119	Single lab
Multivariate Detection Limits Estimators	1996	R. Boque, F.X. Rius	Chemometrics and Intelligent Laboratory Systems 32: 11-23	Single lab
Nomenclature in Evaluation of Analytical Methods including Detection and Quantification Capabilities	1995	Lloyd Currie	Pure & Appl. Chem. 67: 1699-1723	Single lab
Reporting Low-Level Analytical Data Third Draft (1995-11-08) -- New Project of Commission V.I., International Union of Pure and Applied Chemistry	1995	William Horwitz	IUPAC	Single lab
IUPAC Recommendations for Defining and Measuring Detection and Quantification Limits	1994	LA Currie, W. Horwitz	Analyses Magazine 22: 24-26	Single lab
Recommendations for the Presentation of Results of Chemical Analysis	1994	L.A. Currie, G. Svehla	Pure & Applied Chemistry 66: 595-608	Single lab
Detarchi-A Program for Detection Limits with Specified Assurance Probabilities and Characteristic Curves of Detection	1994	L. Sarabia, M.C. Ortiz	TRAC-Trends in Analytical Chemistry 13: 1-6	Single lab
Quality Control Level: An Alternative to Detection Levels	1994	D.E. Kimbrough, J. Wakakuwa	Environmental Science & Technology 28: 338-345	Single lab
Multivariate Decision and Detection Limits	1993	A. Singh	Analytica Chimica Acta 277: 205-214	Single lab
A Model of Measurement Precision at Low Concentrations	1993	P.M. Berthouex, D.R. Gan	Water Environment Research 65: 759-763	Single lab
Robust Procedure for Calibration and Calculation of the Detection Limit of Trimipramine by Adsorptive Stripping Voltametry at a Carbon Paste Electrode	1993	M.C. Ortiz, J. Arcos, J.V. Jurarros, J. Lopez-Palacios, L.A. Sarabia	Analytical Chemistry 65: 678-682	Single lab
Nondetects, Detection Limits, and the Probability of Detection	1991	D. Lambert, B. Peterson, I. Terpenning	JASA 86: 266-277	Single lab
Detection Limits: For Linear Calibration Curves with Increasing Variance and Multiple Future Detection Decisions	1991	R.D. Gibbons, F.H. Jarke, K.P. Stoub	Waste Testing and Quality Assurance: ASTM STP 1075, D. Friedman, Ed., American Society for Testing and Materials, Philadelphia 3: 337-390	Single lab
Limits of Detection in Multivariate Calibration	1991	G. Bauer, W. Wegscheider, H.M. Ortner	Fresenius Journal of Analytical Chemistry 340: 135-139	Single lab
Estimating Detection Limits in Ultratrace Analysis. Part I: The Variability of Estimated Detection Limits	1991	C.L. Stevenson, J.D. Winefordner	Applied Spectroscopy 45:1217-1224	Single lab
Reporting Low-Level Data for Computerized Data Bases	1988	M. Brossman, G. McKenna, H. Kahn, D. King, R. Kleopfer, J. Taylor	ACS Symposium Series 361:317-327	Single lab
Detection Limits with Specified Assurance Probabilities	1987	C.A. Clayton, J.W. Hines, and P.D. Elkins	Analytical Chemistry 59: 2506-2514	Single lab
Limit of Detection and Limit of Determination - Application of Different Statistical Approaches to an Illustrative Example of Residue Analysis	1987	J. Vogelgesang	Fresenius Zeitschrift Fur Analytsche Chemie 328: 213-220	Single lab
Determining the Lowest Limit of Reliable Assay Measurement	1983	L. Oppenheimer, T.P. Capizzi, R.M. Weppelman, H. Mehta	Analytical Chemistry 55: 638-643	Single lab
Principles of Environmental Analysis	1983	L.H. Keith, W. Crummett, J. Deegan Jr, R.A. Libby, J.K. Taylor, G. Wentler	Analytical Chemistry 55: 2210-2218	Single lab

Title	Year	Author	Source	Category
Trace Analyses for Wastewaters	1981	John Glaser, Denis Foerst, Gerald McKee, Stephan Quave, William Budde	Env. Sci. & Tech 15: 1426-1435	Single lab
Guidelines for Data Acquisition and Data Quality Evaluation in Environmental Chemistry	1980	MacDougall, Daniel, <i>et al.</i>	Anal. Chem. 52: 2242-2249	Single lab
Sensitivity and Limit of Detection in Quantitative Spectrometric Methods	1974	J.D. Ingle Jr.	Journal of Chemical Education, 51, 100-105.	Single lab
Decision and Detection Limits for Linear Calibration Curves	1970	A. Hubaux, G. Vos	Analytical Chemistry 42: 849-855	Single lab
Limits for Quantitative Detection and Quantitative Determination	1968	L.A. Currie	Analytical Chemistry 40: 586-593	Single lab
A Statistical Method for Evaluation of Limiting Detectable Sample Concentrations	1967	P.A. St. John, W.J. McCarthy, J.D. Winefordner	Analytical Chem. 39: 1495-1597	Single lab
Initial Evaluation of Quantitative Performance of Chromatographic Methods Using Replicates at Multiple Concentrations	2001	M.A. Castillo, R.C. Castells	Journal of Chromatography A 921: 121-133	Single lab - multilevel
Multivariate Detection Limits with Fixed Probabilities of Error	1999	R. Boque, M.S. Larrechi, F.X. Rius	Chemometrics and Intelligent Laboratory Systems 45: 397-408	Single lab - multilevel
Evaluation of Approximate Methods for Calculating the Limit of Detection and Limit of Quantification	1999	M.E. Zorn, R.D. Gibbons, W.C. Sonzogni	Environmental Science & Technology 33: 2291-2295	Single lab - multilevel
Limits of Detection, Identification and Determination: A Statistical Approach for Practitioners	1998	J. Vogelgesang, J. Hadrich	Accreditation Quality Assurance 3: 242-255	Single lab - multilevel
Weighted Least-Squares Approach to Calculating Limits of Detection and Quantification by Modeling Variability as a Function of Concentration	1997	M.E. Zorn, R.D. Gibbons, W.C. Sonzogni	Analytical Chemistry 69: 3069-3075	Single lab - multilevel
Detection Limits in GC-MS Multivariate Analysis	1997	Boque R et al.	Quimica Analytica, 16(2), 81-86	Single lab - multilevel
An Alternative Minimum Level Definition for Analytical Quantification	1997	Robert Gibbons, David Coleman, Raymond Maddalone	Environmental Science & Technology 31: 2071-2077	Single lab - multilevel
A Two-Component Model for Measurement Error in Analytical Chemistry	1995	David Rocke, Stefan Lorenzato	Technometrics 37: 176-184	Single lab - multilevel
Practical Quantitation Limits	1992	R.D. Gibbons, N.E. Grams, F.H. Jarke, K.P. Stoub	Chemometrics and Intelligent Laboratory Systems 12: 225-235.	Single lab - multilevel
Experimental Comparison of EPA and USATHAMA Detection and Quantitation Capability Estimators	1991	C.L. Grant, A.D. Hewitt, T.F. Jenkins	American Laboratory 23: 15-33	Single lab - multilevel
High Pressure Liquid Chromatography Determination of the Intermediates Side Reaction Products in FD&C Red No. 2 and FD&C Yellow No. 5: Statistical Analysis of Instrument Response	1978	C.J. Bayley, E.A. Cox, J.A. Springer	J. Assoc. Off. Anal. Chem 61: 1404-1414.	Single lab - multilevel
Method Detection Limits: Application to Organic Environmental Chemistry Data	2002	Wade, T. L., J. L. Sericano, Y. Qian, G. Wolff, and G. Denoux	Presentation at ACS Symposium, Boston, MA, August 2002	Suggested by a peer reviewer

Title	Year	Author	Source	Category
Detection limits	2002	van der Voet, H.	Encyclopedia of Environmetrics, 1, El-Shaarawi, A. H. and Piegorsch, W. W. (eds.), 504-515. Chichester: John Wiley & Sons	Suggested by a peer reviewer
Statistical Approaches to Estimating Mean Water Quality Concentration with Detection Limits	2002	Shumway, R., R. Azari, and M. Kayhanian	Environmental Science and Technology 36: 3345-3353	Suggested by a peer reviewer
Detection Limit of Isotope Dilution Mass Spectrometry	2002	Yu, L. L., J. D. Fassett, and W. F. Guthrie	Analytical Chemistry, 74: 3887-3891	Suggested by a peer reviewer
ISO 17025 Requirements: How to Evaluate Uncertainty for Dioxin Analysis in Food and Feed from Validation Data?	2002	G. Eppe, and E. De Pauw	Proceedings of the 22nd International Symposium on Halogenated Environmental Organic Pollutants and POPs, Barcelona, Spain, August 12-18, 2002, Vol. 59, pp. 403-406, 2002	Suggested by a peer reviewer
Are Target Dioxin Levels in Animal Feedingstuffs Achievable for Laboratories in Terms of Analytical Requirements? Results of an Interlaboratory study	2002	G. Eppe, and E. De Pauw	Proceedings of the 22nd International Symposium on Halogenated Environmental Organic Pollutants and POPs, Barcelona, Spain, August 12-18, 2002, Vol. 59, pp. 407-410, 2002	Suggested by a peer reviewer
Environmental Statistics with S-PLUS	2001	Millard, S. P., and Neerchal, N. K.	Chapman & Hall/CRC, Boca Raton, FL	Suggested by a peer reviewer
Quantifying Uncertainty in Analytical Chemistry	2000	Ellison, S. L. R., M. Roslein, and A. Williams, eds.	EURACHEM/CITAC Guide 2000	Suggested by a peer reviewer
Development and Harmonisation of Measurement Uncertainty Principles. Protocol for Uncertainty Evaluation from Validation Data	2000	Barwick V.J., Ellison S.L.R.	VAM Project 3.2.1	Suggested by a peer reviewer
Statistical Procedures for Analysis of Environmental Monitoring Data & Risk Assessment	1998	McBean, E. A., and Rovers, F. A.	Prentice Hall PTR, Upper Saddle River, NJ	Suggested by a peer reviewer
Foundations and future of detection and quantification limits	1996	Currie, L. A.	Proceedings of the American Statistical Association, Section on Statistics and the Environment, 1-8	Suggested by a peer reviewer
Statistical Methods for Groundwater Monitoring	1994	Gibbons, R. D.	John Wiley & Sons, New York	Suggested by a peer reviewer
Spatial chemostatistics	1994	Cressie, N.	Environmental Statistics, Assessment, and Forecasting, Cothorn, C. R. and Ross, N. P. (eds.), 131-146. Boca Raton, FL: Lewis Publishers	Suggested by a peer reviewer
Hypothesis testing with values below detection limit in environmental studies	1994	Slyman, D. J., de Peyster, A., and Donohoe, R. R	Environmental Science & Technology 28: 898-90	Suggested by a peer reviewer
A new approach for accommodation of below detection limit data in trend analysis of water quality	1994	Nagaraj, N. K., and Brunenmeister, S. L.	Environmental Statistics, Assessment, and Forecasting, Cothorn, C. R. and Ross, N. P. (eds.), 113-127. Boca Raton, FL: Lewis Publishers	Suggested by a peer reviewer
Errors and detection limits	1992	Adams, M. J.	In Methods of Environmental Data Analysis, Hewitt, C. N. (ed.), 181-212. Amsterdam: Elsevier Applied Science	Suggested by a peer reviewer

<b>Title</b>	<b>Year</b>	<b>Author</b>	<b>Source</b>	<b>Category</b>
Statistical inference from multiply censored environmental data	1991	El-Shaarawi, A. H., and Naderi, A	Environmental Monitoring and Assessment 17: 339-347	Suggested by a peer reviewer
Less than obvious: Statistical treatment of data below the detection limit	1990	Helsel, D. R	Environmental Science & Technology 24: 1766-1774	Suggested by a peer reviewer
Environmental tests: Are they valid?	1990	Maynard, A. W.	Chemical Technology 20: 151-155.	Suggested by a peer reviewer
Detection in Analytical Chemistry: Importance, Theory, and Practice	1988	Currie, L. A.	American Chemical Society, New York	Suggested by a peer reviewer